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POWER SUPPLY

VOLTAGE REGULATED
DUAL POWER SUPPLY

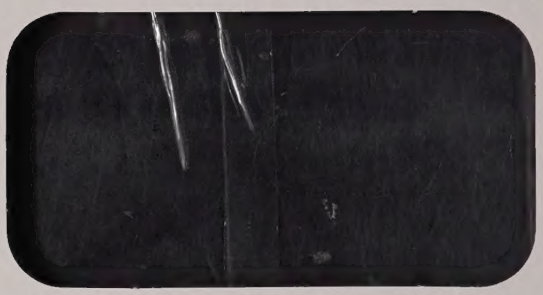
MODEL 2SC 100-0.2

SERIAL NO. .....

INSTRUCTION MANUAL

kepco inc.®

131-38 SANFORD AVENUE • FLUSHING, N. Y. 11352
Area Code 212 IN 1-7000 • TWX # 212-539-6623



SERIES CONNECTION

Kepco Voltage Regulated Power Supplies can be connected in series for increased voltage, provided the specified limits on the voltage to chassis are not exceeded. When series connected, supplies should be protected by means of a semiconductor diode, reverse-connected across the output terminals of each power supply. The peak reverse voltage (PRV) rating of this diode should be chosen to be at least as large as the voltage rating of the supply to which it is connected. The forward (continuous) current rating of the diode should be capable of carrying the largest short circuit current of the series inter-connected supplies.

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INSTRUCTION MANUAL

VOLTAGE REGULATED DUAL POWER SUPPLY

MODEL 2SC 100-0.2

SERIAL NO. .....

kepco 131-38 SANFORD AVENUE • FLUSHING, N.Y. 11352 • PHONE: (212) IN1-7000 • TWX#212-539-6623

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SECTION A. SPECIFICATIONS AND DESCRIPTION

A-1. ELECTRICAL AND PHYSICAL SPECIFICATIONS

The power supply has two outputs each of which conforms to the following electrical specifications.

AC INPUT VOLTAGE: 105-125 volts, 50-65 cps single phase, 1.5 amperes.

DC OUTPUT VOLTAGE: 0-100 volts continuously variable.

DC OUTPUT CURRENT: 0-200 milliamperes continuous duty.

REGULATION:

- LOAD: 0.01% or 0.002 volt, whichever is greater, for a load current of 0-200 milliamperes.
- LINE: 0.01% or 0.002 volt, whichever is greater, for a line fluctuation from 105-125 volts.

STABILITY: The output voltage variation for a period of eight hours (after warm up) is less than 0.01% or 0.002 volt, whichever is greater.

TEMPERATURE COEFFICIENT: The output voltage changes less than 0.01% per degree C.

RIPPLE VOLTAGE: Less than 1 millivolt rms under all conditions.

OUTPUT IMPEDANCE: DC to 100 cps: less than 0.05 ohm; 100 cps to 1 KC: less than 0.03 ohm; 1 KC to 100 KC: less than 0.08 ohm plus 0.5 μh.

RECOVERY TIME: 50 microseconds.

RESOLUTION: 0.005% with 10 turn voltage control.

AMBIENT OPERATING TEMPERATURE: -20C to +50C maximum.

MAXIMUM VOLTAGE ABOVE OR BELOW GROUND: 500 volts DC.

MULTIPLE OPERATION: The power supply outputs can be connected in series but not in parallel. The outputs are isolated from each other.

OUTPUT TERMINATIONS: All terminals are isolated from the chassis. Either positive or negative of each output may be grounded. A ground terminal is provided for connecting to the chassis. The DC terminals, remote programming, and remote sensing connections are brought out to the rear in a barrier strip.

REMOTE PROGRAMMING: Provisions are made at the rear for remote programming at 300 ohm/volt. This allows a voltage control to be placed at a distance from the supply.

REMOTE ERROR SIGNAL SENSING: Provision is made at the rear for remote error signal sensing of the load. This enables regulation to be maintained at the load.

PROTECTIVE FEATURES:

Current Limit Adjust: Can be set to 120% of full load. Current is limited to pre-set value for any load including short circuit.

Over-Temperature: A pre-set temperature sensing device will turn the equipment off if the temperature exceeds the maximum permissible temperature.

Fuses: The input fuse is on the front panel. The reference amplifier is separately fused.

CONTROLS: Power on-off switch and 10 turn voltage control is available on front panel. Current limit control is on rear of unit.

METERS: 0-0.2 ampere Ammeter and 0-50 volts Voltmeter included for each output.

PHYSICAL SPECIFICATIONS: Height 5-1/4", width 19", depth 13", color Kepco standard gray hammertone. The unit is designed for relay rack mounting or bench use. Carrying handles are provided on the front panel.

SECTION B.

THEORY OF OPERATION

The basic operation of the transistorized supply is very similar to its vacuum tube counterpart. The output voltage is kept within regulation limits by the automatic adjustment of the voltage across a series pass transistor. This is effected by negative feedback in a closed loop system in which the output is compared to a reference. Any disparity between the output and the reference is fed back, amplified, and applied to the pass elements to correct the error.

Referring to the schematic diagrams in the rear of the manual, the operation of the unit will be described in detail. In this dual supply model the two power units are basically the same, therefore, in order to avoid unnecessary repetition only Unit I will be discussed.

MAIN SUPPLY AND PASS ELEMENTS:

Unregulated AC for the main supply is taken from transformer T201 and rectified by diodes CR605-CR608 in a full wave bridge circuit. Capacitor C201 provides filtering while R201 acts as a bleed resistor. There are four series pass transistors between the rectified current and the output: Q901, Q903, Q905, Q907. The voltage in excess of the output voltage is divided approximately evenly among the four pass transistors by resistors R202, R203, R204, R205. "Driver" transistors Q301 and Q909 amplify an "error signal" obtained from a comparison of the output with a stabilized reference voltage in the Control Unit, and supply the error signal as a

base input to Q907, reducing or increasing its forward conducting bias so as to oppose output voltage changes. Because of the large current amplification obtained using cascaded base input connections among the amplifiers, pass transistor Q907 is very sensitive to output voltage changes, hence a high degree of output voltage control is maintained.

AUXILIARY SUPPLIES:

1. AC is taken from terminals O and Y of T201 and rectified by diodes CR601-CR604 to provide a minimum operating emitter current to the pass transistors and to enable the power supply to operate when the current through the load is vanishingly small or zero.

2. AC from terminals G, G-Y, G of T203 is rectified by CR613-CR614, filtered by C603, limited by resistors R306, R307 and supplied to the bases of Q909, Q907 to provide stabilization by preventing I_{CO} from operating as a base input signal.

3. AC from terminals Y, Y-R, Y of T203 is rectified by CR611-CR612 and filtered by C602. This supply provides -6 volt collector voltage for drivers Q301 and Q909.

4. AC from terminals R, R-Y, R of T203 is rectified by CR609-CR610, filtered by C601 and supplied to the Control Unit through connector pins 1 and 2.

THE BRIDGE CIRCUIT AND THE CONTROL UNIT:

1. Output voltage is compared to the reference voltage in a bridge circuit. The four arms of this bridge are: (1) potentiometer R101, (2) resistors R14, R13, R12 in the Control Unit, (3) reference Zener diode

RD1, (4) the output load resistance. If the bridge is unbalanced, the voltage at the base of Q7 initiates an error signal amplified in cascade and biased in such a way that the pass transistors are driven to compensate for the voltage imbalance. That is to say, constant voltage output is maintained by a system of negative or degenerative feedback. Transistors Q7, Q8, Q9 in the Control Unit amplify the error signal to the level required to operate the drivers and pass transistors in the Power Unit via connector pin #5.

The Maximum Current Adjust circuitry automatically limits the maximum current through the pass elements. This prevents damage to the transistors from overloading.

REFERENCE VOLTAGE CIRCUITRY:

The function of the reference voltage circuitry is to maintain a constant precise voltage across Zener diode RD1. This is effected by regulation of the current through RD1.

The circuitry shown to the left of RD1 on the Control Unit schematic is a small regulated power supply. Regulation is by means of a system of balanced amplifiers. Any disparity between the voltage across RD1 and that across R4 is coupled from the collectors of Q5 and Q6 to the bases of Q2 and Q3, amplified and applied to Q4 and Q1. Q1, functioning as a pass transistor, adjusts the supply voltage to the reference diode according to the bias of its base input signal.

SECTION C.

OPERATING INSTRUCTIONS

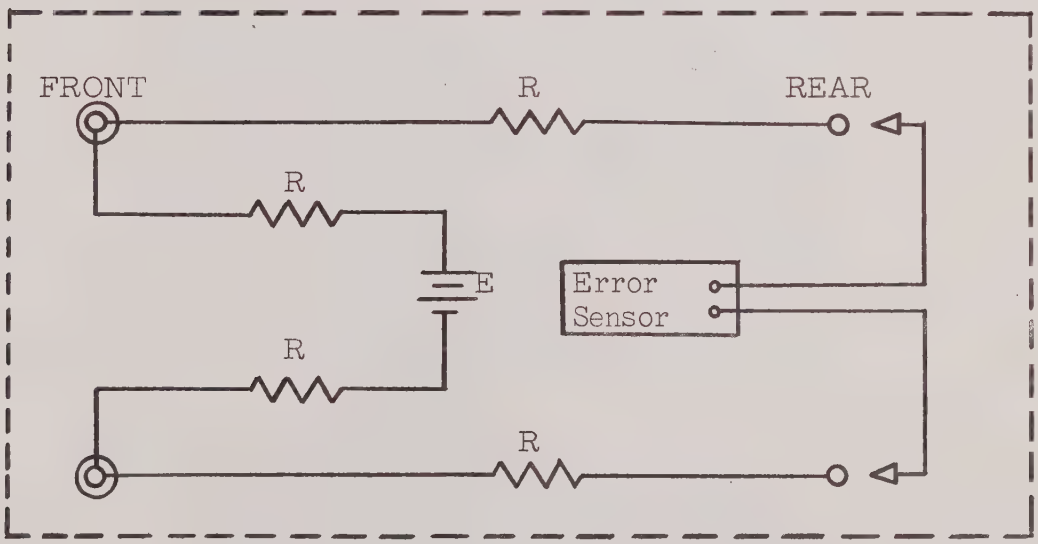
STANDARD OPERATION: The Kepco Model 2SC-100-0.2 Semi-Conductor Voltage Regulated Power Supply is shipped without internal packing materials and may be place into operation immediately.

In order to achieve the best regulation of the voltage across a load under all conditions, it is important to have an understanding of the error signal feature of the supply.

The supply is wired as shown in Figure I.

If a load is connected to the front, and the error signal jumpers left in place, the maximum regulation will be achieved. This will also be true if the load is connected to the rear. However, if a load is connected to the front and rear at the same time the load at the rear will receive the best regulation. The front terminal voltage will be higher by the amount of the IR drop in the buss from the front to the rear terminals. Connection to both the rear and front terminals at the same time is, therefore, not recommended if best regulation at the front terminals is desired.

SIMPLIFIED DIAGRAM OF ERROR SENSING FEATURE



R = Buss Resistance

E = Internal Power Supply Voltage

FIGURE I.

REMOTE ERROR SIGNAL OPERATION: With the power supply turned off, remove the jumper bars from the error signal terminals located on the rear terminal board. Use twisted pair wire for connecting the + and - error signal terminals to the load. The load can be connected from the front or rear terminals with twisted pair leads. The error signal leads must be place directly across the load for best results. (See Figure II.)

REMOTE ERROR CONNECTIONS

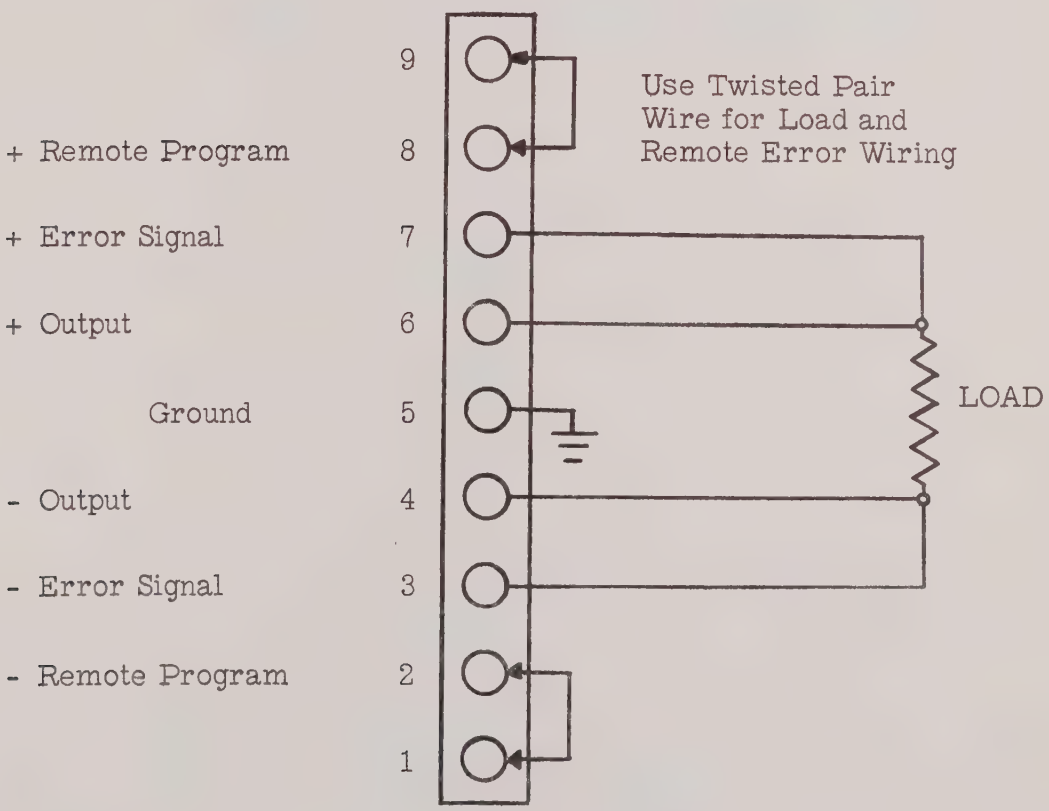


FIGURE II.

REMOTE PROGRAMMING OPERATION: With the power supply turned off, remove the jumper bars from the remote program terminals located on the rear terminal board. (See Figure III.) Use shielded twisted pair wire for connecting the + and - remote program terminals to the remotely located voltage control. The unit is set so that a resistance variation of 300 ohms in the remotely located voltage control will cause a change in output voltage of approximately one volt.

REMOTE VOLTAGE CONTROL CONNECTIONS

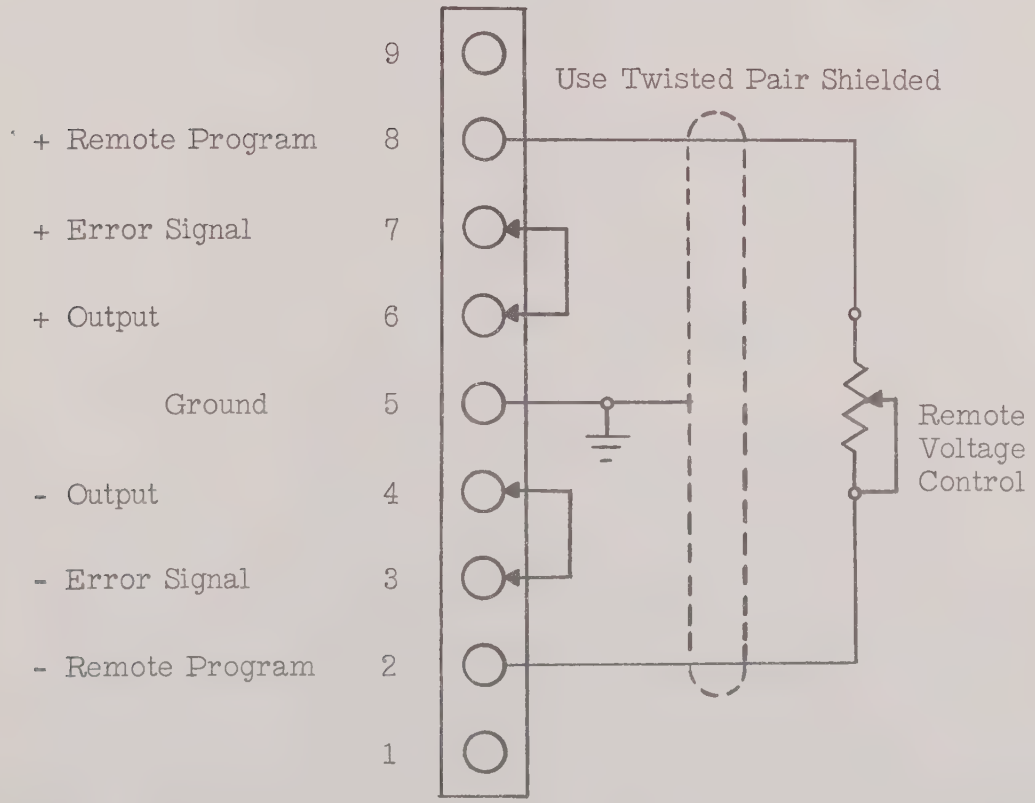


FIGURE III.

PROCEDURE FOR CONVERTING THIS VOLTAGE REGULATED POWER SUPPLY TO A CURRENT REGULATED POWER SUPPLY: This supply can be operated in such a manner that a constant current rather than constant voltage can be maintained in the external load. Applications for this type of modification include maintaining constant current through magnet solenoids, filament loads, and other loads which change slowly.

Figure IV indicates the external electrical modifications required for converting to a constant current mode of operation. The essential changes include removing the minus remote program jumper, inserting a current sensing resistor R in series with the external load R_L, inserting a 350 MF capacitor across R_L, and a 500 ohm control for setting the constant current value.

The value of the current sensing resistor R is selected so that there is a one volt drop across it for the maximum output current of the supply. For example: If the maximum current is to be 0.2 ampere R is 5 ohms. In this case, the output current can be set anywhere in the range 0 to 0.2 ampere with the constant current control.

When the supply is to be used at a much lower current level than the maximum output current, best current regulation can be achieved by selecting the largest value of current sensing resistor R. For example, if the maximum desired current is to be 0.1 ampere, the current sensing resistor R should be 10 ohms. For this case, the output current can be set anywhere in the range 0 to 0.1 ampere with the constant current control.

Constant current will be maintained throughout the impedance range 0 to R_L (MAX.).

R_L (MAX.) is determined by the equation R_L (MAX.) = V (MAX.)/I. (e.g.) V (MAX.) = 100 volts, I = 0.2 A; R_L (MAX.) = 500 ohms.

CURRENT REGULATED OPERATION

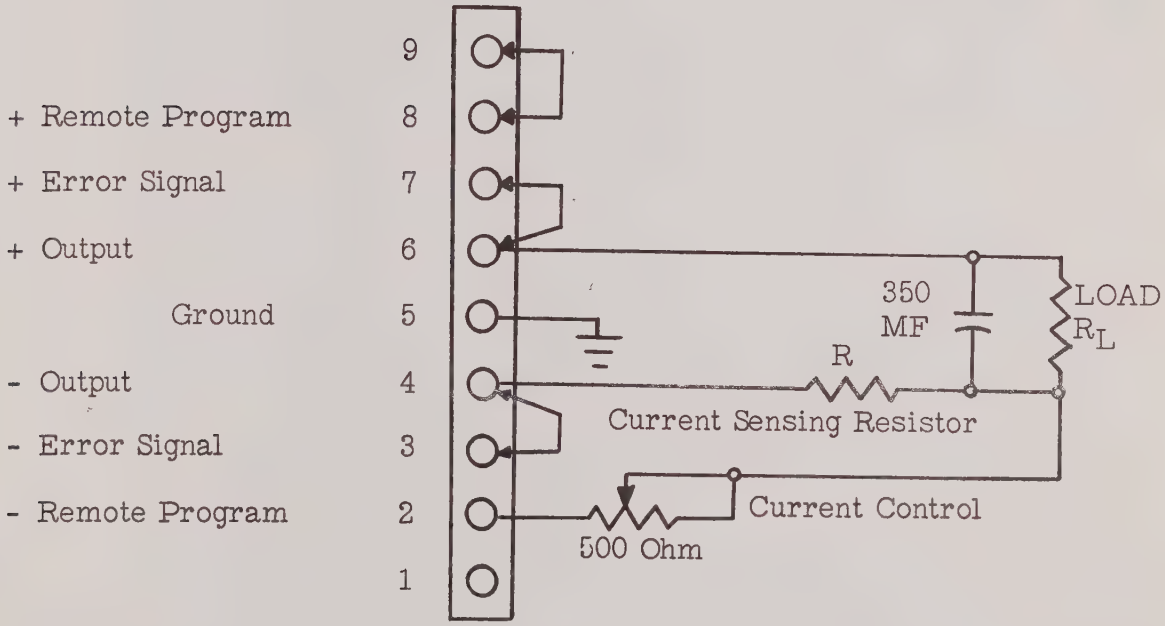


FIGURE IV.

Procedure for selecting the remote program control - To remote control the voltage through the operating range 0 to 100 volts, it is necessary to vary the remote control resistance from 0 to 30,000 ohms. If remote control over a limited voltage range is desired (e.g. 28 to 32 volts) the remote control resistance must be varied from approximately 8,000 ohms to 10,000 ohms. Use twisted pair shielded wire for minimum ripple.

SECTION 4
MAINTENANCE AND REPAIRS

4-1 GENERAL INFORMATION. -

The performance of this Power Supply will in a sense be dependent on the collective performance of all of its components. Kepco chooses and tests these components to provide long life and trouble-free operation of the unit.

However, if component failure should occur, it is recommended that troubleshooting be handled by personnel familiar with transistor circuitry, preferably with experience in feedback regulator design. The essential regulating circuitry is a closed-loop DC servo system. The same circuit sensitivity which enables a high degree of regulation to be obtained also increases the susceptibility of the circuit to interrelated functional disorders if the equipment is improperly serviced.

....REFERENCE MATERIAL. -

The Instruction Manual furnished with the Power Supply is identified with the serial number of the unit, assuring that the information it contains is correct and current for the unit to which it applies. The following reference material is provided in the Manual to aid in troubleshooting and repairs:

1. Large schematic diagrams showing essential voltage measurements and component values.

2. Parts location photos or drawings.

3. Parts lists identifying all replacement parts with description and specifications, and the name and manufacturer's part number of at least one replacement source for each item.

....FACTORY REPAIRS. -

If it becomes necessary or desirable to return the equipment to KEPCO for servicing, it should not be shipped to the factory without the sender having prior authorization and shipping instructions. The inclusion of detailed information with the unit, or in correspondence preceding its return to the factory will greatly expedite completion of repairs and return of the equipment to the sender.

In any correspondence with the factory about this Power Supply, the model and serial numbers should always be included.

4-2 MAINTENANCE. -

Under normal operating conditions, only a minimum of maintenance may be required.

1. Fan Assemblies. - If the unit is equipped with muffin-type fan assemblies (black impeller, motor enclosed in hub), this type is permanently lubricated by the manufacturer and does not require relubrication. The open frame type of motor may be lubricated lightly every six months.

2. Brushes. - In units that contain a variable transformer, the brush assembly should not as a rule ever require maintenance or replacement. If it is desired to clean the commutator track, use only a soft cloth moistened lightly with an electrical cleaner (not a solvent). Never use any type of abrasive material on the track.

3. Vacuum Tube Replacement. - Vacuum tubes may be replaced as required when they become defective, or at arbitrary intervals of either life or use. Unless specifically indicated, tubes may be replaced individually and need not be replaced in sets or groups.

4. Performance Tests. - If the unit is to be tested and measured to determine its performance with respect to Regulation, Ripple, etc., the section in the Manual on Regulation Measurements should be read, and the recommended procedures contained therein, or their equivalent, should be followed to aid in obtaining accurate test measurements.

....PRELIMINARY TROUBLESHOOTING CHECKS. - Before proceeding with any extensive electrical troubleshooting, it is advisable to carefully check the Supply for any operational or mechanical disorders.

1. Check for broken, loose, or shorted terminals, wires, and connections; loose connectors, open or loose fuses, tripped circuit breakers, etc. Check all internal as well as external fuses.

2. If the malfunction relates to an overtemperature condition, check to see that the fans work properly and that the openings weren't blocked during operation. On units with overtemperature protection be sure to allow enough time for the thermostat switch to cool and to restore to normal position.

3. Check all operational functions and controls for proper settings. For example, on units with automatic current limiting, a low current setting can, under certain conditions, have the effect of limiting the output voltage, which may appear to be a malfunction. Check to determine whether any internal adjustments may have been reset for any reason, and left at a setting that is incorrect.

4-3 NOTES ON TRANSISTOR SERVICING TECHNIQUES.

....MECHANICAL.

1. A transistor should not be disconnected from, or connected to its circuit while voltage is still present in the circuit.

2. When a soldering iron must be used to remove or install a transistor, or a diode, the heat of the iron while it is being applied to the terminals will almost certainly damage the component unless precautions are taken to prevent it:

   a. When soldering, always apply a temporary "heat sink" to the leads between the iron and the semiconductor to drain off the heat travelling up the lead.

      Note: Pliers are often used for this purpose - be sure they are effective; e.g., flat blade "duck-bills" are good, narrow blade or "toothed" long-nose pliers may be poor.

   b. Solder quickly, so as to limit the application of heat to the briefest possible duration. In this respect use a good iron with proper and sufficient heat for the connection. An iron of too low heat tends to require longer application.

3. When removing or installing a transistor or a diode which has its case connected to one of its elements, be sure to preserve the arrangement of any insulating materials, such as mica washers or bushings.

4. When installing plug-in transistors which have flexible leads, be sure to align the leads and socket pins properly; especially in the "universal" sockets which were designed to accommodate more than one lead pattern.

....ELECTRICAL.

1. Transistor Testers. - Transistor checking instruments, either commercial types or those of local design, may be used. These are usually effective and practical, but not in every case, depending on many circumstances including the accessibility of the unit under test, and the range of the instrument.

2. In-Circuit Analysis. - In some cases the condition of a transistor may be determined by observing certain of its electrical characteristics while it is operating in the circuit. These may range from voltage readings to AC analysis with an oscilloscope.

....ELECTRICAL. (continued)

3. Ohmmeter Check. - Transistor failures of a more complete nature such as shorted or open junctions may be easily detected by test with an ohmmeter. However, some precautions are necessary:

   a. Use the low ohms scale only (Rx1), and then only if the source voltage of the meter (battery) is not more than 2 volts. The use of a higher range or one with high battery voltage may give erroneous indications and might even damage a transistor.

   b. The "common: or black terminal on most ohmmeter instruments is the Positive terminal of the ohmmeter battery, not negative as is commonly believed. When checking semiconductors with an ohmmeter it is usually necessary to know the polarity of this voltage in order to interpret the readings obtained. Some manufacturers of ohmmeters are now indicating this polarity on their meters.

   c. An ohmmeter test between any two terminals of a transistor indicates by the needle deflection whether it is conducting ohmmeter current between those two terminals; and the amount of deflection is related to the amount of this current and to the voltage drop developed across the junction. The actual reading in ohms is not as significant as are other conclusions from the readings. With the polarity of the meter applied as a forward bias to either the base-emitter or base-collector junction, forward current should flow with the needle deflecting on the order of 5-50 ohms; with the polarity reversed in either case, only leakage current flows with little or no perceptible deflection. In both cases the apparent ratio between readings of opposite applied polarity should be on the order of at least 100 to 1. A reading between emitter and collector should be high in both directions.

   d. When an ohmmeter is used to test a transistor that is still in the circuit, the parallel effects of other components in the circuit should be taken into consideration.

4. Substitution. - The above procedures are very often used to localize a trouble down to a circuit area or to one component with final proof dependent on substituting a known good component. It is possible for one bad transistor in a circuit to "pull" another one with it. When a transistor is found to be defective, it should not be replaced before all others have been checked, including those which would appear to be not directly associated in the circuit with the defective one.

....DIODES.

1. Most of the preceding material on transistors is applicable to diodes, except that diodes are two terminal devices consisting of a single junction. The ratio of "front to back" readings on an ohmmeter should similarly be on the order of 100 to 1.

2. When replacing diodes, be sure to observe the proper polarity:

   a. The "triangle" of a diode symbol represents the anode and "points" in the direction of forward conduction under conditions of applied forward bias.

   b. Diodes are marked with their polarity in terms of their output and the cathode is marked positive (+).

....ZENER DIODES.

1. Zener diodes may be checked with an ohmmeter provided they are of a single junction type. Double anode types have a common cathode which is not brought out to a terminal. Thus, whichever polarity of the ohmmeter is applied to the two anode terminals, it will read a high resistance reverse bias in both directions. A short however, can be detected. Manufacturers are not yet consistent in their marking of polarity on Zeners; before disconnecting a Zener, be sure to note its markings with respect to the terminals to which it is connected.

2. A positive test of a Zener diode is to measure the voltage across it while it is in operation. If instrumentation is available, the voltage regulation across its terminals should be measured and compared to its ratings.

4-4 POWER SUPPLY MEASUREMENTS. -

....DEFINITIONS -

Line Regulation. - Stated in percentage of the output voltage, Line Regulation specifies the maximum amount that the output voltage will change as the result of a specified change in line voltage, with the load maintained at a constant value.

Load Regulation. - Stated in percentage of the output voltage (or in actual value) specifies the maximum amount that the output voltage will change as the result of a specified change in output load current, with the line voltage maintained at a constant value.

MEASURING REGULATION. -

Load Regulation and other performance characteristics can be measured at any point in a system. However the results obtained will apply only to the specific point at which they are measured, and may differ from what is specified for the output of the Supply. If it is desired to measure or to verify the performance of the Supply itself, the measurements should be made at the terminals on the Supply, using instrumentation and procedures that are capable of measuring with the desired accuracy.

As an example, consider a Kepco Model SC 32-5, 32 volt/5 ampere Supply which has 0.01% regulation. At 32 volts, the output voltage at the terminals will not change more than 3.2 millivolts (0.0032 v) for a change from no-load to full-load. If the load were to be connected by only 12 inches of #12 gage wire in each lead, at full-load the total drop across the resistance in these wires would amount to 16 millivolts, equivalent to 5 times the voltage change within regulation. The regulation measured at the load would be 0.05% while at the terminals it would measure 0.01%.

Instrumentation. -

1. Line Voltage. - By definition, load regulation is specified, and measured with a condition of constant line voltage. A constant voltage transformer or other source of constant AC is required. If the AC source is also adjustable it can be used to vary or step the line voltage input for measuring Line Regulation.

2. Load. - An accurate full-load is required, preferably one that can be conveniently applied, or stepped on and off by some switching means.

3. Measurement. - Any instrument may be used that is capable of measuring both the absolute value of the output voltage, and the small magnitude of change in the output voltage occurring as the line or load changes are applied.

a. A differential voltmeter may be used; or a power supply analyzer such as the Kepco Regulation Analyzer Model 901C which gives measurements directly in percentage.

b. A DC coupled oscilloscope may be used, if a suitable auxiliary DC voltage is available to buck-out the voltage under test so that only the net change can be measured. The buck-out voltage must be at least equal in magnitude to, and have a greater order of regulation than the voltage under test.

Procedure. -

1. On Supplies that have more than one set of output terminals (most Kepco Supplies have terminals on the front and the rear) measurement can be made at either set, except on those Supplies where the regulation is specified for one particular set of terminals. In any case, both the load and the measuring instrument should be connected to the same terminals.

2. To avoid terminal losses giving erroneous measurements, on each output terminal connect the load to one end and the instrument to the other end of a short length of #14 bus wire looped around the terminal, as shown in Fig. 4-1.

3. The Supply should not be set up for Remote Error sensing where this facility is provided. Error Sensing jumpers to the output terminals, where employed, should be securely in place.

....RIPPLE MEASUREMENT.

Any AC ripple component present in the DC output of a properly functioning Power Supply will be small in magnitude, on the order of millivolts. It is usually stated in the specifications for the Supply either in millivolts RMS or in percentage (in RMS) of the output voltage. Because of its small magnitude, a sensitive instrument must be used to measure the ripple, and care must be exercised in order to obtain accurate readings.

1. Be certain that the input to the measuring instrument contains a blocking capacitor to isolate the DC voltage from the ripple component, and that the DC voltage rating of the capacitor is sufficiently high for the DC output voltage that will be applied.

2. Some rectifier types of AC meters do not contain a DC blocking capacitor, and DC current will pass through the rectifier to the meter movement. In such cases, or where the internal capacitor does not have a high enough DC rating, a 0.1 μf capacitor (with sufficiently high DCWV) connected in series with the high side of the input will insure isolation of the DC from the ripple.

3. Interconnecting leads between the Power Supply and the instrument should be short and preferably shielded to prevent stray AC pickup. When using a measuring instrument that is connected to the same power line, be certain to have good connections in the interconnecting leads to avoid the introduction of a ground loop.

CONNECTIONS FOR REGULATION MEASUREMENT

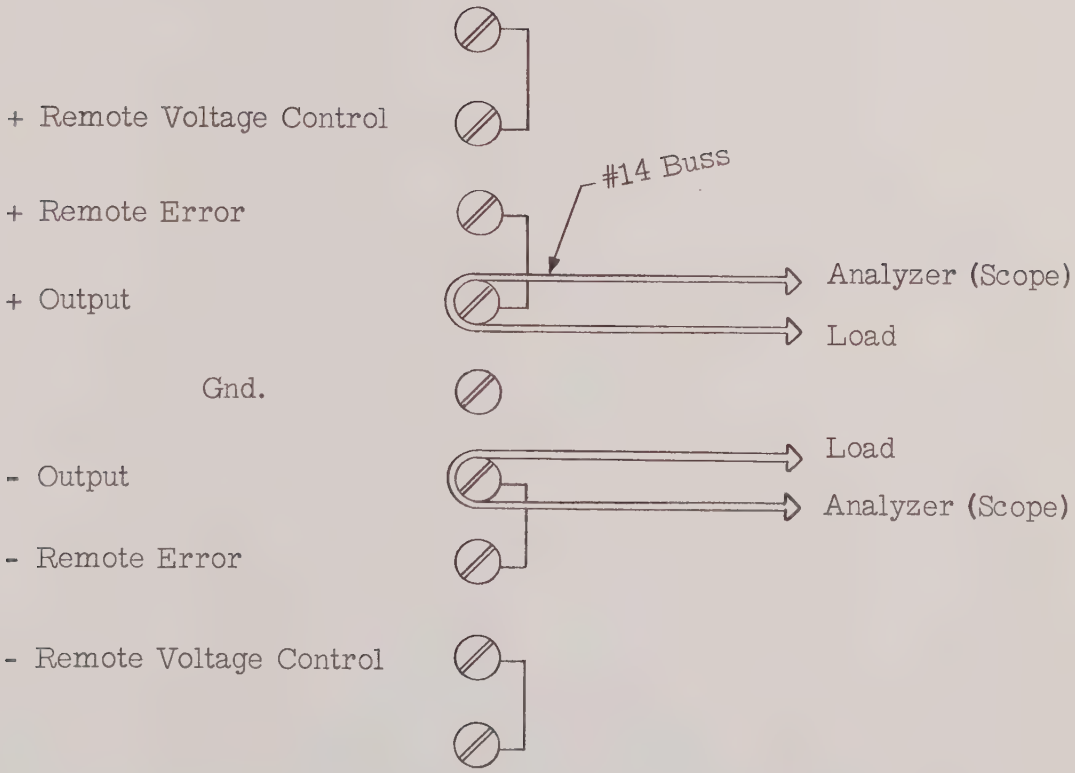


Fig. 4-1 Connections for Measuring Regulation

SECTION E.

ADJUSTMENTS

MAXIMUM CURRENT ADJUST: The automatic current limiting device in this unit is part of the regulator amplifier circuit. If the current tends to exceed a pre-set value, the control amplifier sends a signal to the pass elements limiting the current to a pre-set value. The "Maximum Current Adjust" control limits the current to a factory pre-set value. Normally, the customer does not touch the "Maximum Current Adjust". This control is set to 120% of the rated supply current. Should it become necessary to readjust the maximum overload current setting, remove the rear cover and loosen the locking nut on the "Maximum Current Adjust" potentiometer labelled "MC". Clockwise rotation increases the maximum current limiting. For best results, the overload current should be set 20% higher than the maximum desired output current.

"Maximum Current Adjust" corrections when remote programming is used - When the load is to be remotely located with respect to the power supply, the "Maximum Current Adjust" must be corrected for the voltage drop in the load leads. The unit under these circumstances will limit to a current less than the factory pre-set value. The controls are set in the following manner. First, the supply is loaded with a remotely connected resistor which will draw slightly more than 120% of rated supply current at the indicated supply output voltage. The "Maximum Current Adjust" should then be turned clockwise until the output current is exactly 120% of maximum supply current.

SECTION F

OVER-TEMPERATURE PROTECTION

In the event of fan failure or accidental blocking of air vents, a temperature measuring device, mounted on one of the series pass transistor elements, will automatically turn the power off when the temperature is excessive. It is important that the air vents are not blocked. The unit vents should not be placed too close to other equipment which generates heat. Otherwise, the over-temperature device will keep turning the supply off. The fan will be kept operating even though the power supply has been turned off by the over-temperature protective device. To turn the power supply on again, once an over-temperature condition has occurred, remove the external load from the power supply and wait approximately 3 to 5 minutes for the unit to cool off. The unit will not operate until the power switch is turned off and then on. If the power goes off again the unit has not cooled to a safe operating temperature.

If the fan is operating properly and the air vents are not blocked, there may be internal failure and the internal difficulty should be removed in accordance with the "Repair Notes". If the supply is operating properly reapply the load and let the unit operate for 10 to 15 minutes. Continued safe operation may then be expected. If the supply shuts down with a load not exceeding the rated value of the supply, the unit should be serviced in accordance with the "Repair Notes".

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
B201	1	Motor 115 V, 60 Cps, 1 PH	Barber KYAF 764-1	148-0006
C201,202, 205,206	4	Capacitor,Elec. Can Type 350 Mf, 250 v	Industrial RRB1 13/16 x 3 3/8	117-0187
C203-204	2	Capacitor,Elec.Can Type 150 MF, 450 v	Industrial RRB 1 13/16 x 3 3/8	117-0188
C207,208	2	Capacitor,Ceramic 0.1 mfd, 500 v	Sprague 41C92	117-0087
C209,210	2	Capacitor,Mylar 0.22 Mf, 200 v, 20%	Good All 620S22402W	117-0107
C211,212	2	Capacitor,Mylar 0.2 Mf, 200 v	Hopkins A22M	117-0236
C213,214, 402,502	4	Capacitor,Elec.Pigtail 10 Mf, 150 v	Industrial 10B912RM	117-0147
C301,302	2	Capacitor,Metalized Mylar 0.03 Mf, 200 v	Hopkins	117-0291
C401,501	2	Capacitor,Mylar 0.22 Mf, 200 v	Good All 620S22402W	117-0107
C601,701	2	Capacitor,Elec.Pigtail 350 Mf, 50 v	Industrial RM	117-0114
C602,702	2	Capacitor,Elec.Pigtail 500 Mf, 12 v	Industrial RM	117-0156
C603,703	2	Capacitor,Elec.Pigtail 100 Mfd, 12 v, +100%-10%	Industrial RM	117-0121
CR401,402 501,502 605-608 705-708	12	Silicon Rectifier 500 ma, 380 PIV	Automatic PT-5	124-0028
CR601-604 701-704	8	Silicon Rectifier,Pigtail 250 ma, 500 PIV	Automatic PT550	124-0048
CR609-614 709-714	12	Germanium Rectifier 150 ma, 100 PIV	General Electric 1N91	122-0007
F101-102	2	Fuse 2 amp, slo blo	Bussman	141-0030
F201-204	4	Fuse 1/4 amp. 250 v	Bussman AGC-1/4	141-0005
F205	1	Fuse 1/2 amp, 250 v	Bussman AGC-1/2	141-0002
M101,102	2	Ammeter 0-200 MADC	Simpson 1227	135-0160

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS, REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

POWER UNIT, MODEL 2SC 100-0.2 POWER SUPPLY Code 7-262

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
M103,104	2	Voltmeter 0-100 V.D.C.	Simpson 1227	135-0151
PL101,102	2	Neon Pilot Light	General Electric NE-51	153-0024
Q301,302	2	Transistor,PNP	Tung Sol 119-0022	119-0022
Q901-908	8	Transistor,PNP	Delco 119-0004	119-0004
Q909,910	2	Transistor,PNP	Delco 119-0016	119-0016
R101,102	2	Resistor,Variable 30 K ohm, 1.25 w, 3%	Helipot AR30KL.25	115-0187
R201,206	2	Resistor,Fixed,Power 50 ohm, 20 w, WW	Ward Leonard 20S	115-0777
R202-205 207-210	8	Resistor,Fixed,Power 500 ohm, 20 w, WW	Ward Leonard 20S	115-0551
R211,212 214,215	4	Resistor,Fixed,Power 1000 ohm, 40 w, WW	Ward Leonard 40S	115-0513
R213,216	2	Resistor,Fixed,Power 2000 ohm, 40 w, WW	Ward Leonard 40S	115-0699
R217-220 601,701	6	Resistor,Fixed,Molded 47 ohm, 1/2 w, 10%	Allen Bradley EB4701	115-0718
R301,306	2	Resistor,Fixed,Molded 220 ohm, 1 w, 10%	Allen Bradley GB2211	115-0631
R302,307	2	Resistor,Fixed,Molded 470 ohm, 1 w, 10%	Allen Bradley GB4711	115-0630
R303,308	2	Resistor,Fixed,Power,Axial 7.5 ohm, 3 w, 5%	Ward Leonard 3X7.5	115-0823
R304,305	2	Resistor,Fixed,Power,Axial 10 K ohm, 5 w, 5%	Ward Leonard 5X10000	115-0446
R401,501	2	Resistor,Fixed,Molded 330 K ohm, 1/2 w, 10%	Allen Bradley EB3341	115-0778
R402,502	2	Resistor,Fixed,Power 1 K ohm, 5 w, WW	Ward Leonard 5X	115-0512
RL201,202	2	Relay 3PDT, 115VAC	Line MK-2074	140-0017
S101,102	2	Toggle Switch D.P.S.T.	Carling 2GK-53	127-0010
S901,902	2	Switch,Thermostat	Chatham DRSCORP73C	127-0093
T201,202	2	Power Transformer	Kepco Magnetics 100-1127	100-1127
T203,204	2	Reference Transformer	Kepco Magnetics 100-1039	100-1039

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kepco inc. ® REPLACEMENT PARTS LIST

CONTROL UNIT, MODEL TRAM 9 Code 4-1361

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
C1	1	Capacitor, Electrol, Pigtail Type 25 µf, 25 v	Industrial Cond. 1B1063	117-0105
C2,3	2	Capacitor, Mylar 2 µf, 200 v	Hopkins Eng. 2P2MK	117-0129
C4	1	Capacitor, Ceramic 0.1 µf, 500 v	Sprague 41C92	117-0087
CR1	1	Rectifier, Silicon, Pigtail Type 500 ma, 380 PIV	Automatic Mfg. PT-5	124-0028
Q1	1	Transistor, PNP Field Replacement	Delco 119-0016	**119-0016
Q2,3,4 5,6,8,11	7	Transistor, PNP Field Replacement	Tung-Sol 119-0022	**119-0022
Q9,10,7	3	Transistor, NPN Field Replacement	Tung-Sol 119-0024	**119-0024
R1	1	Resistor, Fixed, Molded 3.3K ohm, 1/2 w, 10%	Allen-Bradley EB3321	115-0439
R2	1	Resistor, Fixed, Molded 2.2K ohm, 1/2 w, 10%	Allen-Bradley EB2221	115-0466
R3,4,11	3	Resistor, Fixed, Power, Axial 500 ohm, 3 w, 5%	Ward Leonard 3X500	115-0459
R5	1	Resistor, Fixed, Molded 4.7K ohm, 1/2 w, 10%	Allen-Bradley EB4721	115-0467
R6,7,10	1	Resistor, Fixed, Power, Axial 2.5K ohm, 3 w, 5%	Ward Leonard 3X2500	115-0469
R8	1	Resistor, Fixed, Power, Axial 10K ohm, 3 w, 5%	Sprague 151E-10K	115-0460
R9	1	Resistor, Fixed, Molded 1.8K ohm, 1/2 w, 10%	Allen-Bradley EB1821	115-0473
R12	1	Resistor, Fixed, Precision 1.8K ohm, 1/2 w, 1%	Dale WS-1/2	115-0736
R13	1	Resistor, Fixed, Power, Axial 100 ohm, 3 w, 5%	Ward Leonard 3X100	115-0471
R14	1	Resistor, Fixed, Power, Axial 200 ohm, 3 w, 5%	Ward Leonard 3X200	115-0803
R15	1	Resistor, Fixed, Power, Axial 300 ohm, 3 w, 5%	Ward Leonard 3X300	115-0444
R16	1	Resistor, Fixed, Molded 4.7K ohm, 1/2 w, 10%	Allen-Bradley EB4721	115-0467
R17	1	Resistor, Fixed, Molded 39 ohm, 1/2 w, 10%	Allen-Bradley EB3901	115-0623

**See Field Replacement Page

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
R18	1	Resistor, Fixed, Molded 1.5 K ohm, 1/2 w, 10%	Allen Bradley EB1521	115-0578
R19	1	Resistor, Fixed, Molded 470 ohm, 1/2 w, 10%	Allen Bradley EB4711	115-0608
R20	1	Resistor, Fixed, Molded 4.7 K ohm, 1/2 w, 10%	Allen Bradley EB4721	115-0467
R21	1	Resistor, Fixed, Molded 10 ohm, 1/2 w, 10%	Allen Bradley EB1001	115-0502
R22	1	Resistor, Fixed, Molded 100 ohm, 1 w, 10%	Allen Bradley GB1011	115-0002
R23	1	Resistor, Variable, Composition 500 ohm, 2 w, 10%	Allen Bradley JA1L040S501UZ	115-0625
R24	1	Resistor, Fixed, Molded 100 ohm, 1/2 w, 10%	Allen Bradley EB1011	115-0626
RD1	1	Zener Diode	Hoffman 1N429	121-0001

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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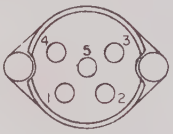
FIELD REPLACEMENT LIST

Kepco Part No.	Description	Recommended Replacement MFR.	MFR. No.
119-0003 119-0016	Transistor PNP	Delco	2N174
119-0022	Transistor PNP	Tung Sol Texas Instrument	2N1707 2N404
119-0034	Transistor PNP	Delco Hughes	2N1172 2N1131A
119-0035, 0036,0037	Transistor PNP	Motorola Clevite	2N1167 CTP 3553
119-0048	Transistor Unijunction	General Electric	2N1671A
119-0020	Transistor PNP	RCA	2N398A
119-0038	Transistor NPN	Transitron	ST29
119-0004	Transistor PNP	Delco	2N277
119-0024	Transistor NPN	General Inst. RCA, General Elec. Texas Instrument Sylvania, Texas Instrument	2N1605 2N388 2N1308
119-0049	Transistor PNP	Delco	2N669
119-0054	Transistor NPN	General Electric	2N338 2N336A
119-0055	Transistor PNP	Hughes	2N1131A

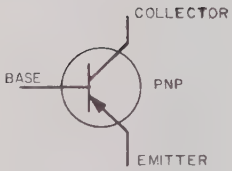
PCB-1 V/I CONTROL BOARD

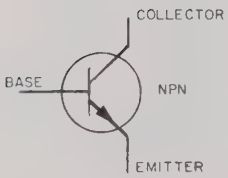
PCB-2 SCR CONTROL BOARD

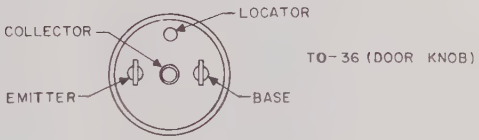
PLUG IN DRIVER AND PASS ASSEMBLIES - CHASSIS SOCKET VIEW

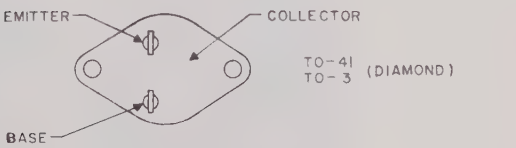


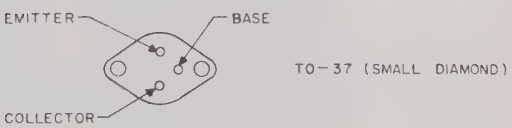
TRANSISTORS

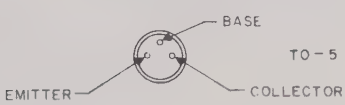




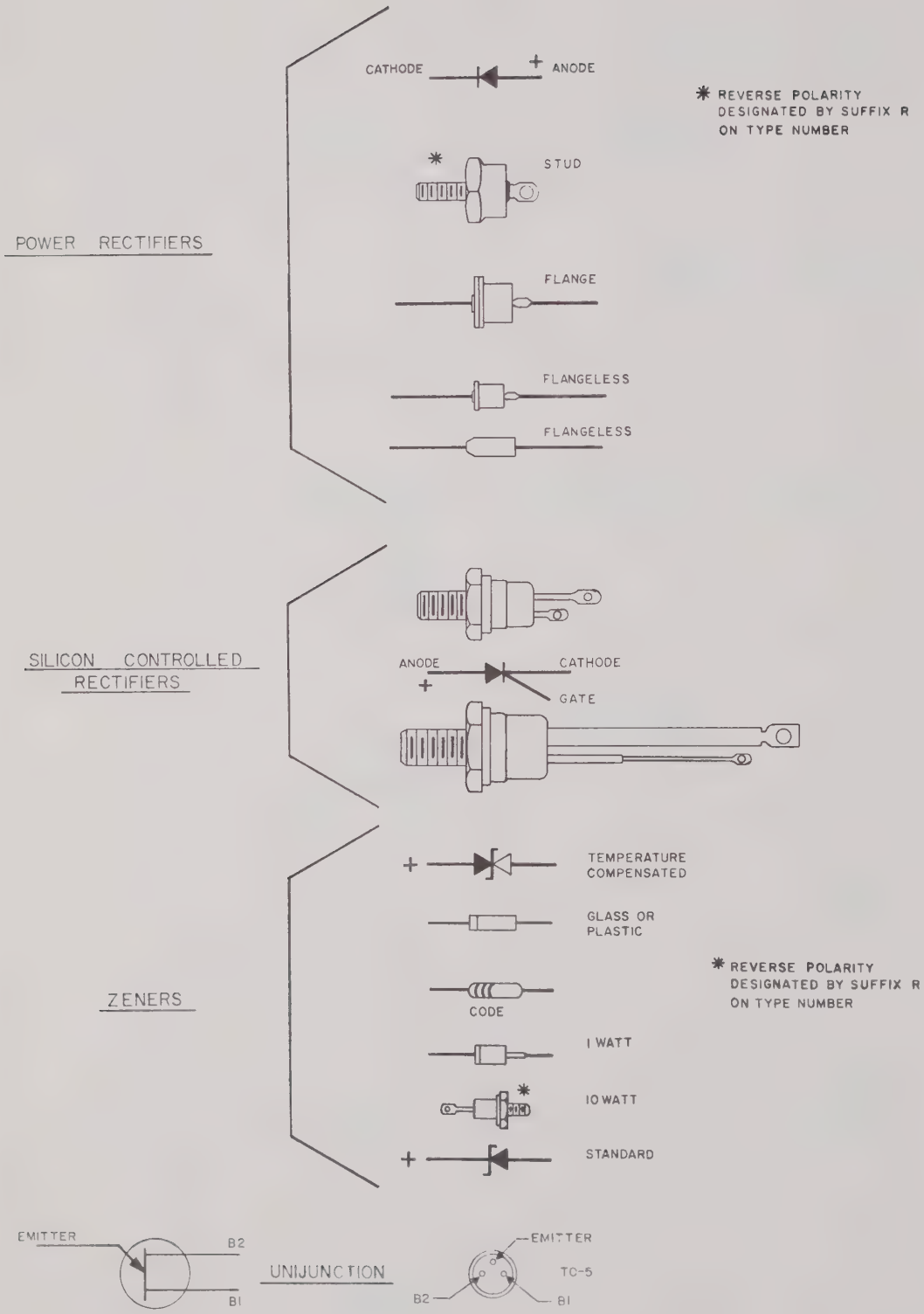




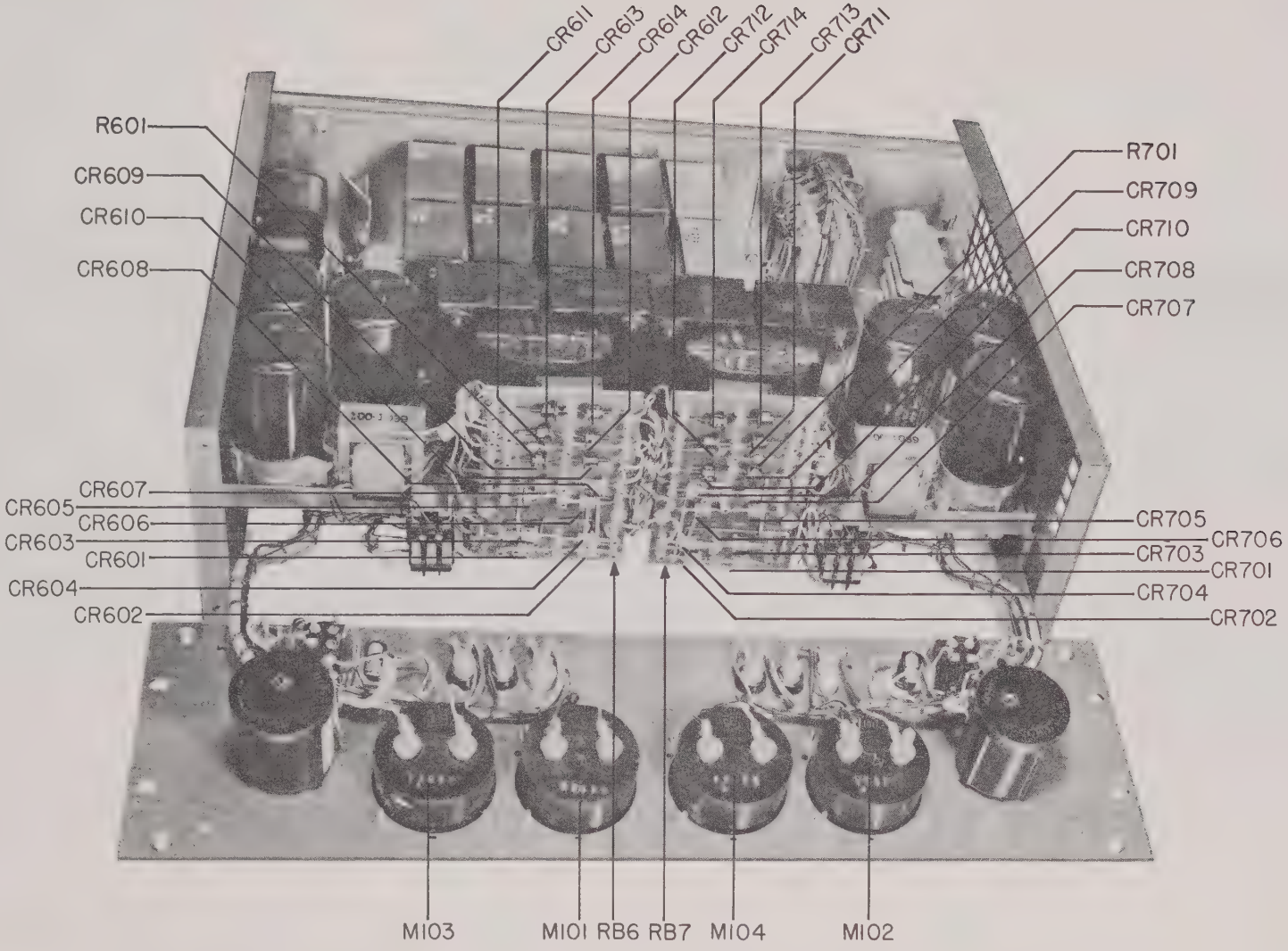




TERMINAL DESIGNATIONS OF CONNECTORS AND COMPONENTS



TERMINAL DESIGNATIONS OF CONNECTORS AND COMPONENTS



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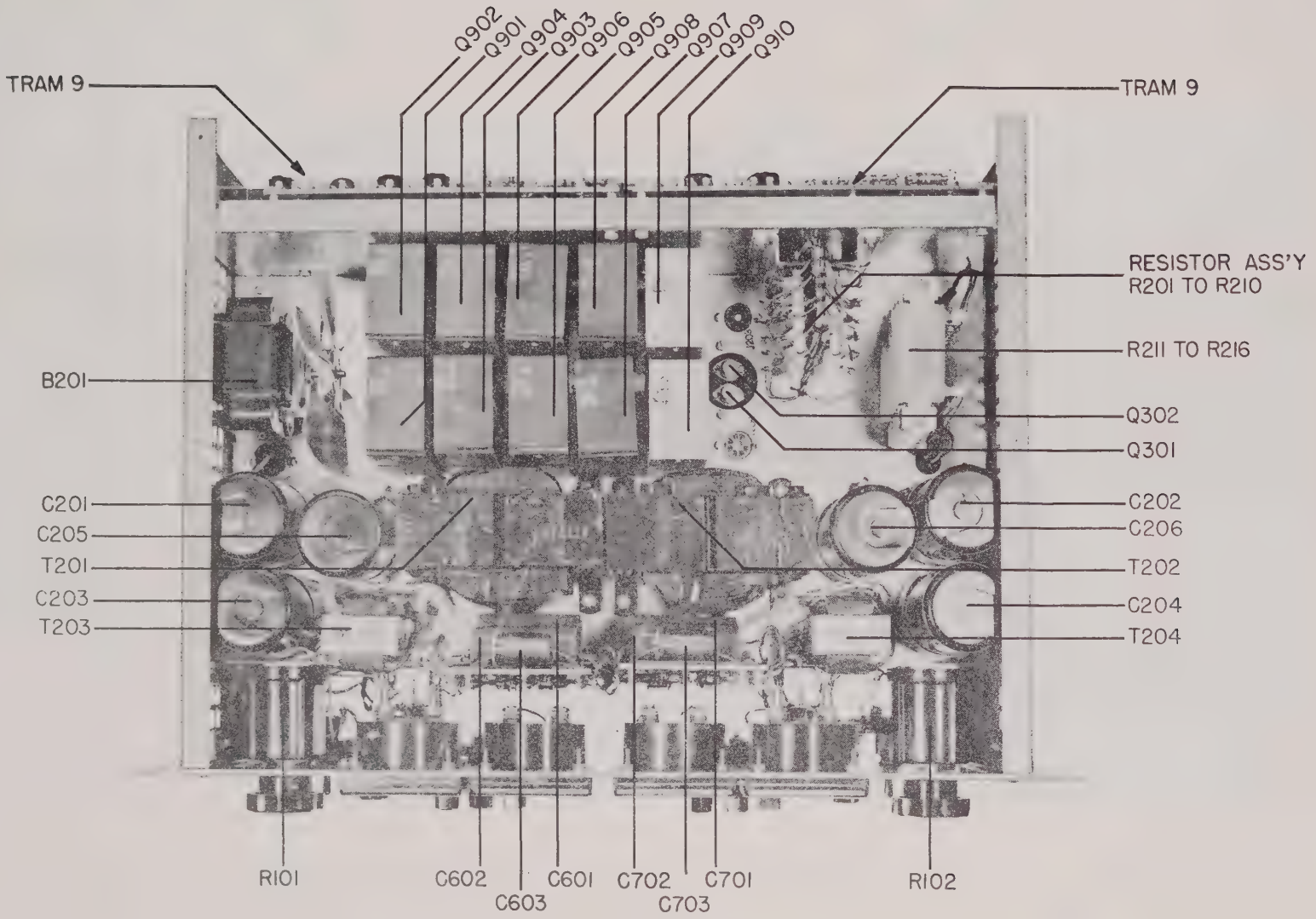
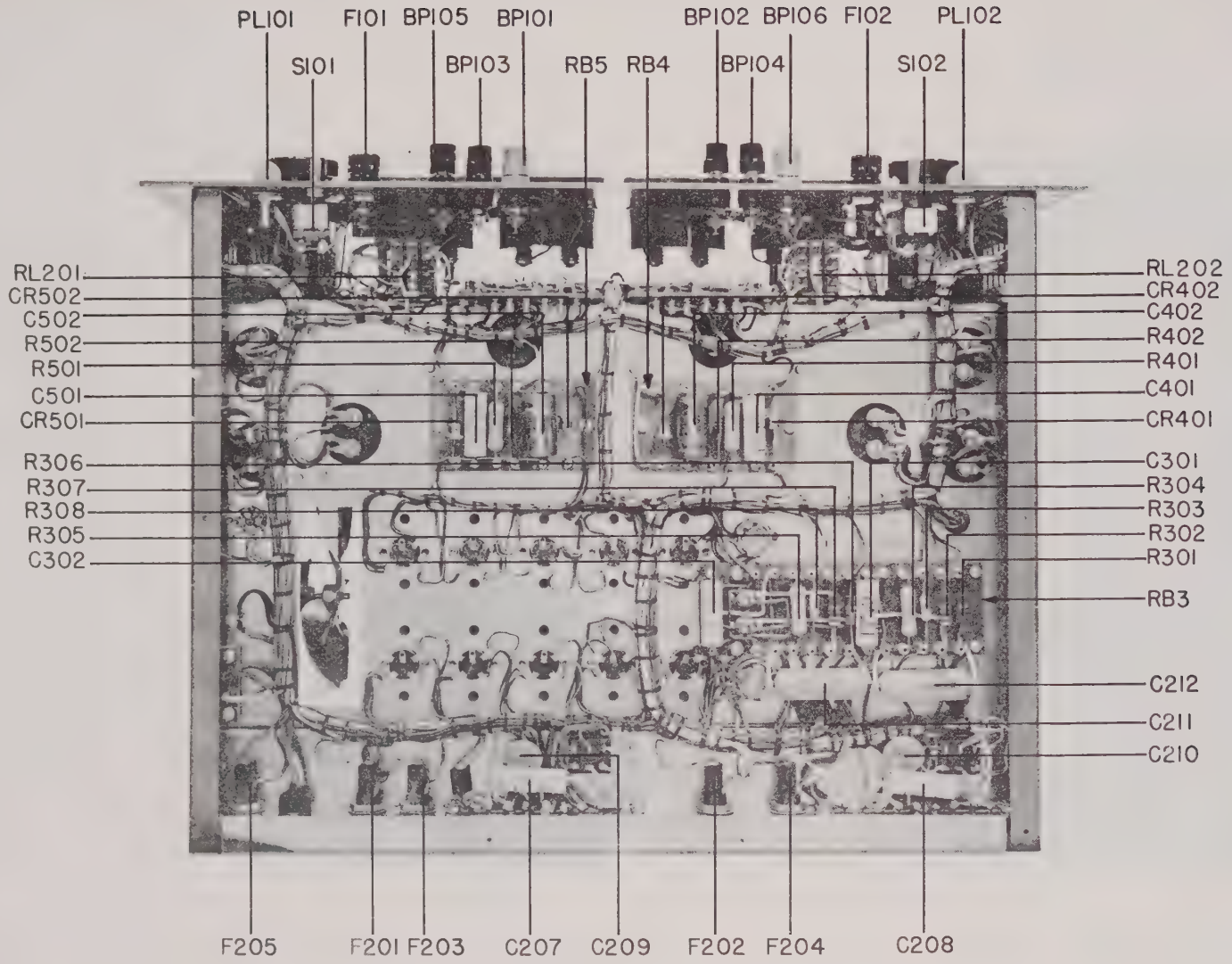
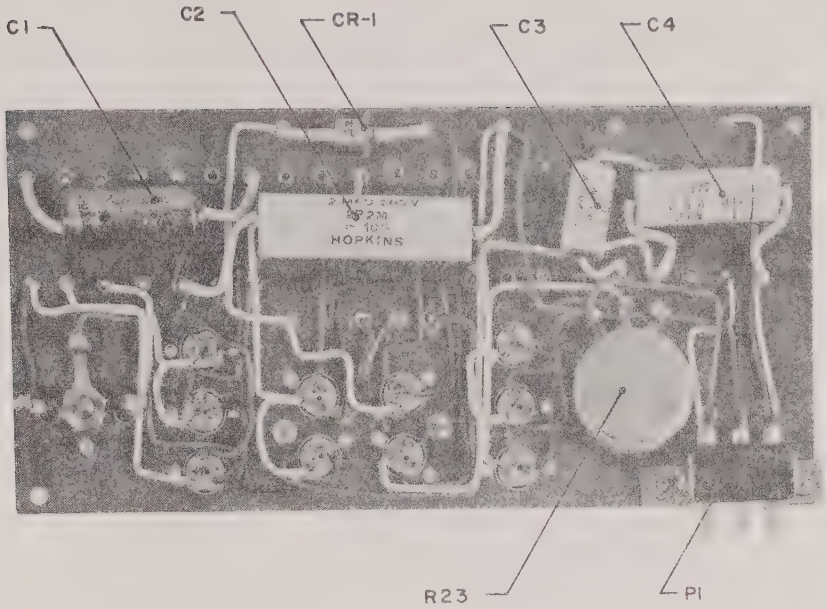
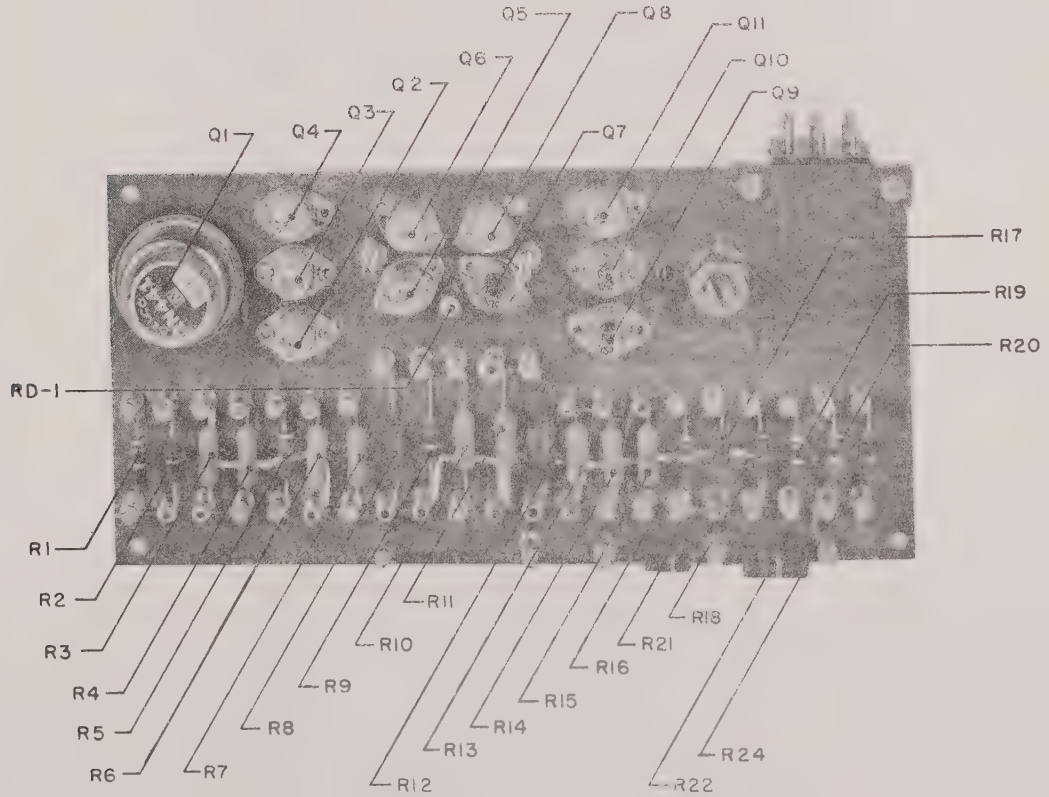


2-SC-100-0.2 TOP



2-SC-100-0.2 BOTTOM

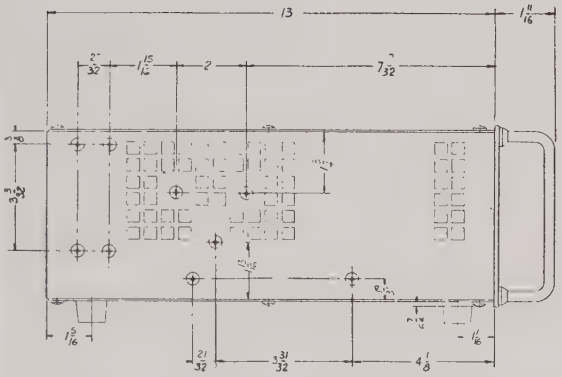




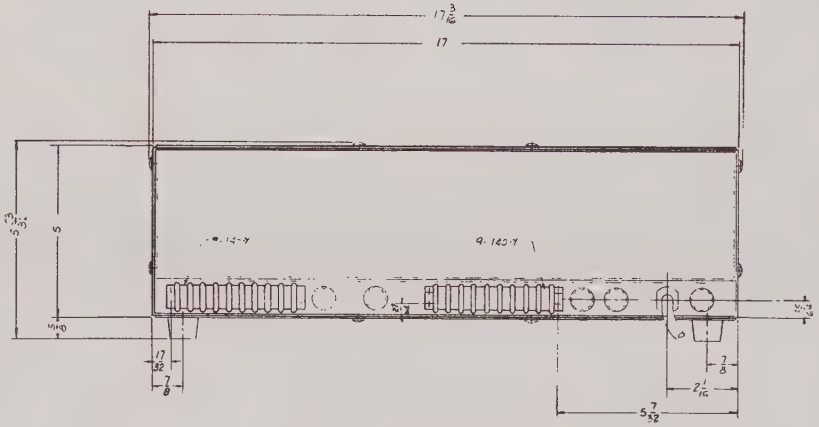
CORRECTIONS, IF ANY, APPEAR ON SHEET ATTACHED TO REAR COVER

CONTROL UNIT
TRAM 9

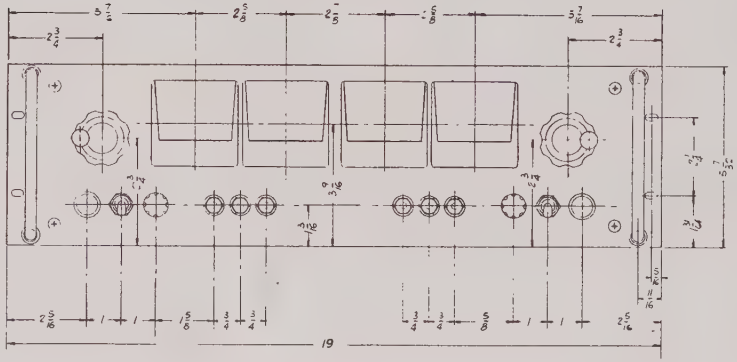
394R60



SIDE VIEW

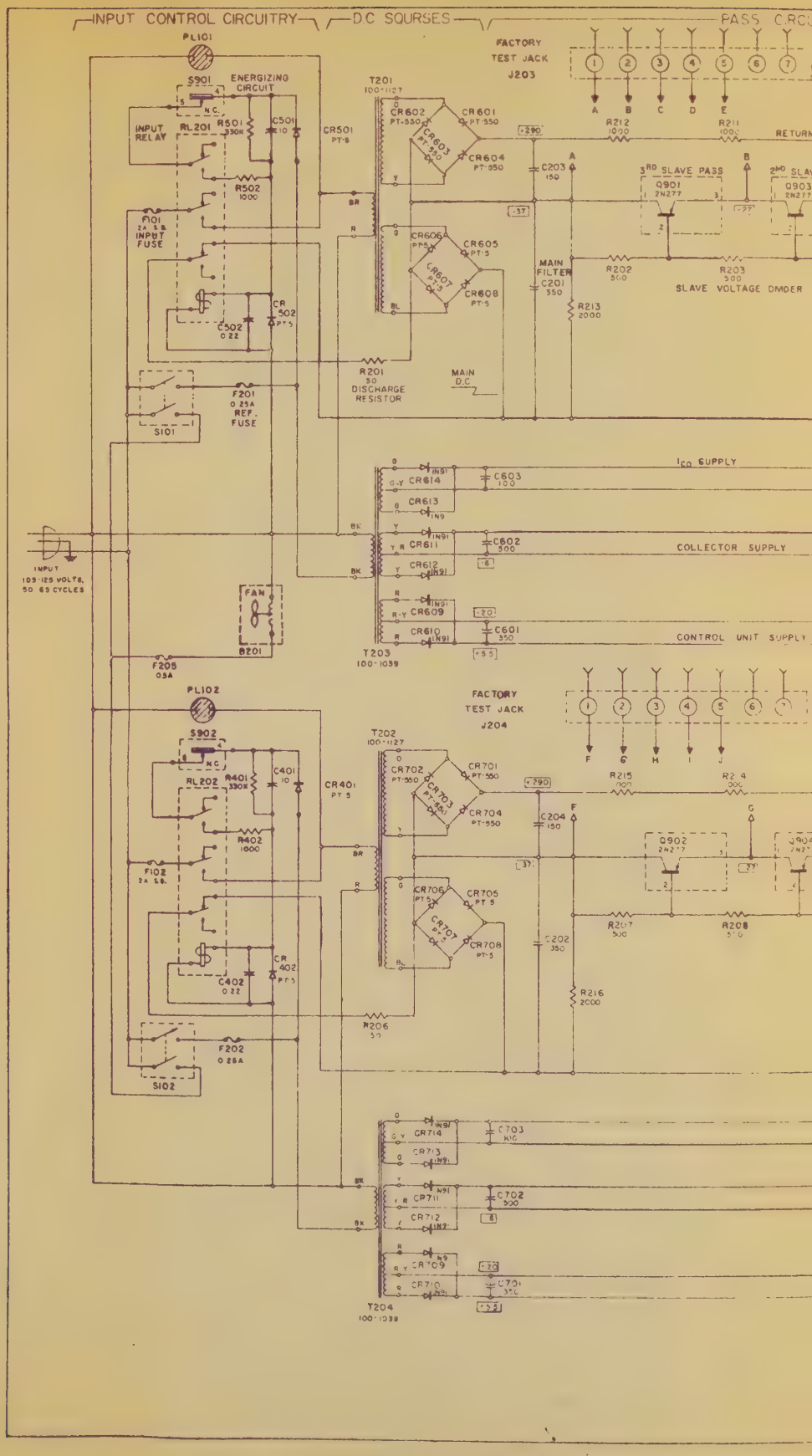


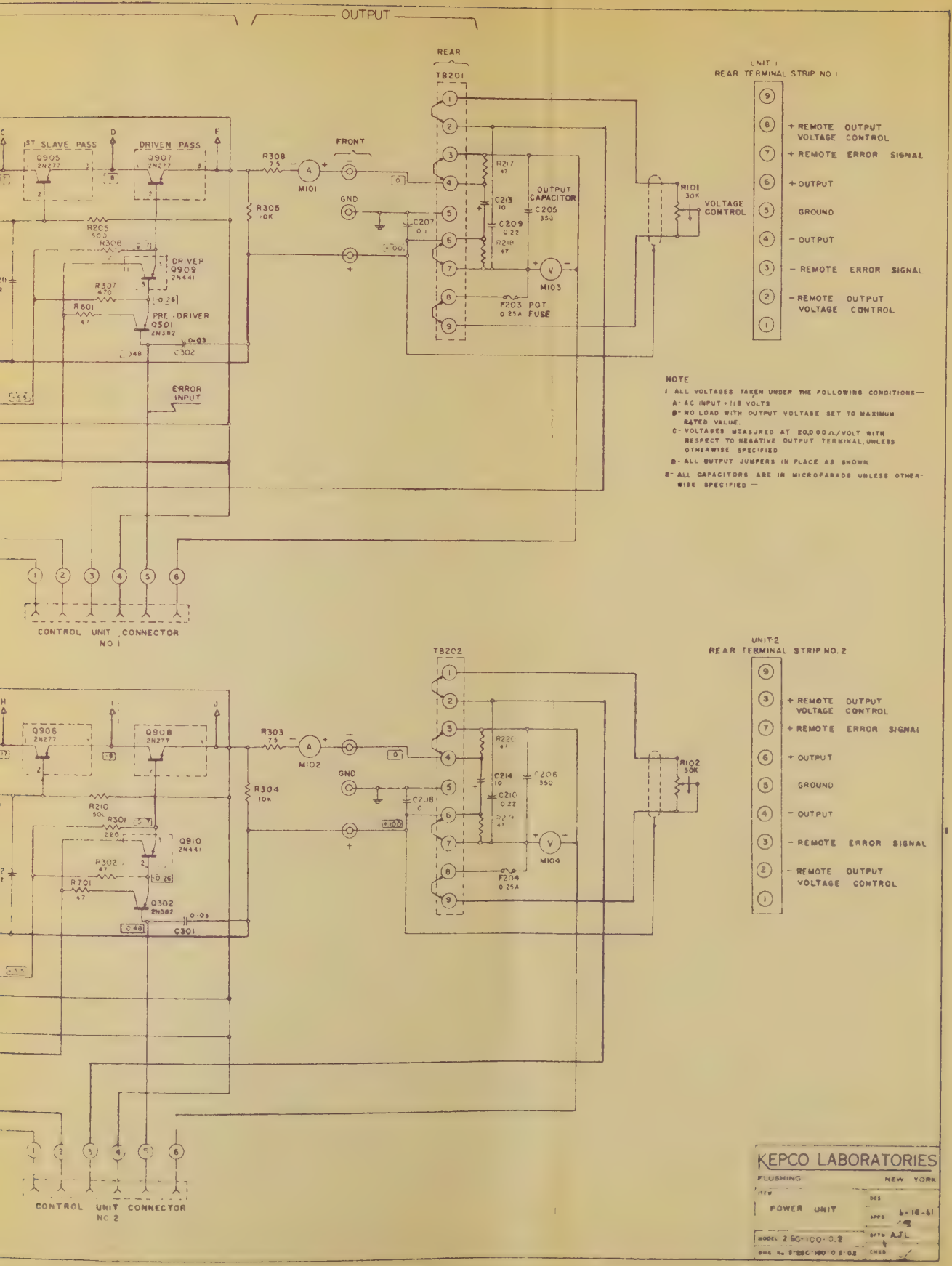
REAR VIEW

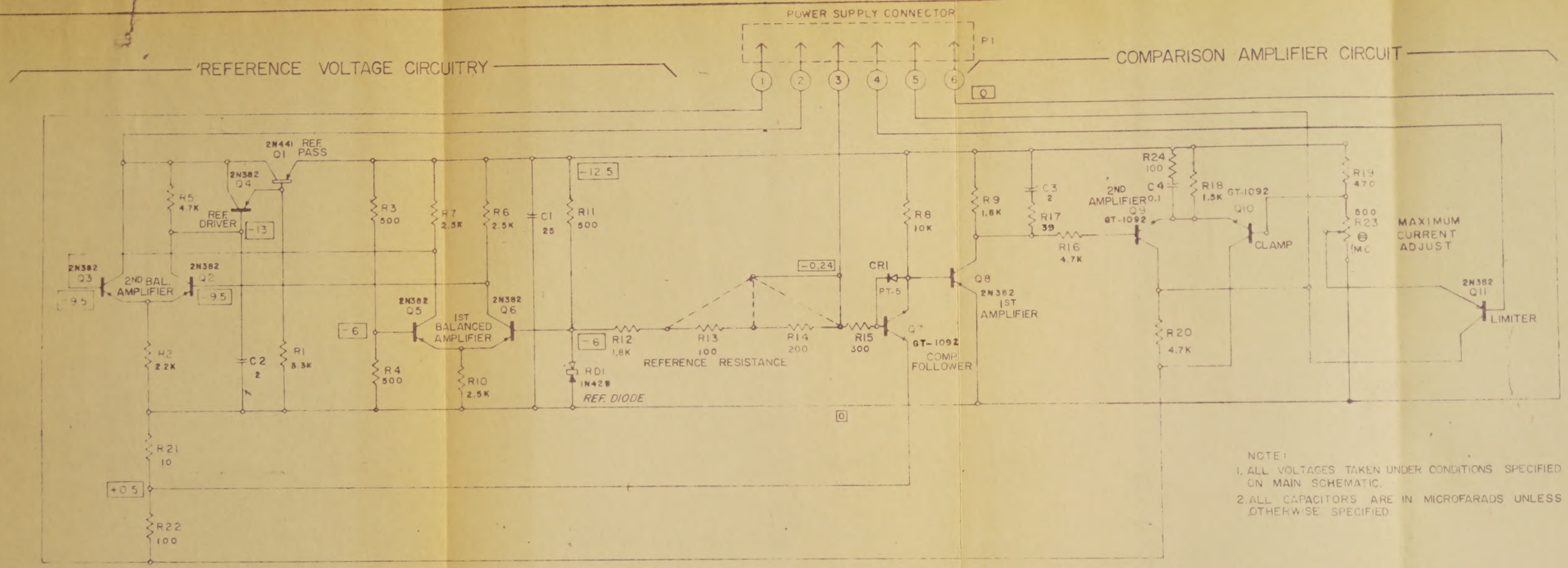


FRONT VIEW

KEPCO LABORATORIES		
FLUSHING NEW YORK		
ITEM: OUTLINE DRAWING	DES.	CHKD.
	APPD.	SCALE:
	DFTR A. C. F.	DATE 2-24-58
MODEL 25C-100-0.2	FINISH	REV. 180
DWG NO. OD-25C100-A2-0	KEPCO 180	


INPUT CONTROL CIRCUITRY
D.C SOURSES
PASS C.RCU
PL101
S901
ENERGIZING CIRCUIT
INPUT RELAY
RL201
R501 330K
C501 10
R502 1000
F101 2A S.B. INPUT FUSE
CR 502
C502 0.22
S101
F201 0.25A REF. FUSE
INPUT 105-125 VOLTS, 50 60 CYCLES
FAN
B201
F205 0.5A
T201 100-1127
CR501 PT-8
CR602 PT-550
CR601 PT-550
CR603 PT-550
CR604 PT-550
CR606 PT-5
CR605 PT-5
CR607 PT-5
CR608 PT-5
R201 30 DISCHARGE RESISTOR
MAIN D.C
FACTORY TEST JACK J203
C203 150
MAIN FILTER C201 350
R213 2000
R212 1000
R211 1000
RETURN
3RD SLAVE PASS
Q901 2N277
R202 500
R203 300
SLAVE VOLTAGE DMDER
I_CO SUPPLY
CR614 IN91
CR613 IN9
C603 100
COLLECTOR SUPPLY
CR611 IN91
CR612 IN91
C602 500
CONTROL UNIT SUPPLY
CR609 IN91
CR610 IN91
C601 350
T203 100-1039
PL102
S902
RL202
R401 330K
C401 10
R402 1000
F102 2A S.B.
CR 402
C402 0.22
S102
F202 0.25A
CR401 PT 5
T202 100-1127
CR702 PT-550
CR701 PT-550
CR703 PT-550
CR704 PT-550
CR706 PT-5
CR705 PT-5
CR707 PT-5
CR708 PT-5
R206 30
FACTORY TEST JACK J204
C204 150
C202 350
R216 2000
R215 1000
R214 300
Q902 2N277
R207 500
R208 500
CR714 IN91
CR713 IN91
C703 .1K
CR711 IN91
CR712 IN91
C702 500
CR709 IN9
CR710 IN91
C701 .35
T204 100-1038


OUTPUT
REAR
TB201
UNIT 1
REAR TERMINAL STRIP NO 1
+ REMOTE OUTPUT VOLTAGE CONTROL
+ REMOTE ERROR SIGNAL
+ OUTPUT
GROUND
- OUTPUT
- REMOTE ERROR SIGNAL
- REMOTE OUTPUT VOLTAGE CONTROL
1ST SLAVE PASS
DRIVEN PASS
Q905 2N277
Q907 2N277
R308 7.5
M101
FRONT
GND
R305 10K
R217 47
C213 10
C209 0.22
R218 47
OUTPUT CAPACITOR C205 350
M103
F203 POT. 0.25A FUSE
R101 30K
VOLTAGE CONTROL
R205 500
R306
DRIVER Q909 2N441
R307 470
R601 47
PRE-DRIVER Q501 2N382
C302
ERROR INPUT
CONTROL UNIT CONNECTOR NO 1
NOTE
1 ALL VOLTAGES TAKEN UNDER THE FOLLOWING CONDITIONS—
A- AC INPUT = 115 VOLTS
B- NO LOAD WITH OUTPUT VOLTAGE SET TO MAXIMUM RATED VALUE.
C- VOLTAGES MEASURED AT 20,000 Ω/VOLT WITH RESPECT TO NEGATIVE OUTPUT TERMINAL, UNLESS OTHERWISE SPECIFIED
D- ALL OUTPUT JUMPERS IN PLACE AS SHOWN
E- ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED —
TB202
UNIT 2
REAR TERMINAL STRIP NO. 2
+ REMOTE OUTPUT VOLTAGE CONTROL
+ REMOTE ERROR SIGNAL
+ OUTPUT
GROUND
- OUTPUT
- REMOTE ERROR SIGNAL
- REMOTE OUTPUT VOLTAGE CONTROL
Q906 2N277
Q908 2N277
R303 7.5
M102
GND
R304 10K
R220 47
C214 10
C210 0.22
C206 350
M104
F204 0.25A
R102 30K
R210 500
R301 220
Q910 2N441
R302 47
R701 47
Q302 2N382
C301
CONTROL UNIT CONNECTOR NO 2
KEPCO LABORATORIES
FLUSHING NEW YORK
ITEM POWER UNIT
DES
APPD 6-18-61
MODEL 2 SC-100-0.2
DWN AJL
CHKD



NOTE:

1. ALL VOLTAGES TAKEN UNDER CONDITIONS SPECIFIED ON MAIN SCHEMATIC.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED

KEPCO LABORATORIES

CONTROL UNIT	DES T.R.P.
	APPD 4-19-6
MODEL TRAM-9	DRTM A.J.L.
DWG No S-TRAM-9-01	CHKD E.I.

kepco inc.

INSTRUCTION MANUAL CORRECTION

Please note the following correction to the Manual Material as indicated:

Parts List & Schematic Diagram:

1. Change R101,102 Resistor,Variable 30 K ohm, 10-Turn Kepco #115-0187 to:
R101,102 Resistor,Variable 30 K ohm, ± 3%, 10-Turn Kepco #115-1204.

2SC100-0.2/11-3064/r8 C1118

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